

PRELIMINARY CRUISE RESULTS

NOAA SHIP *MILLER FREEMAN*, CRUISE NO. 96-12 ECHO INTEGRATION-TRAWL SURVEY OF WALLEYE POLLOCK IN THE EASTERN BERING SEA

CRUISE PERIOD, AREA, AND SCHEDULE

Scientists from the Alaska Fisheries Science Center (AFSC) conducted an echo integration-trawl (EIT) survey of walleye pollock (*Theragra chalcogramma*) aboard the NOAA ship *Miller Freeman* from July 18 to September 2, 1996. The cruise began and ended in Dutch Harbor, Alaska. The survey covered the eastern Bering Sea (EBS) shelf and slope from the Alaska Peninsula in the southeast to the U.S./Russia convention line.

The itinerary for the *Miller Freeman* was as follows (dates are local):

Jul 18	Embark scientists in Dutch Harbor, Alaska
Jul 19	Sphere calibration in Captains Bay
Jul 19-20	Transit to survey start
Jul 20-Aug 5	EIT survey of EBS shelf and slope; touch and go in Dutch Harbor to exchange personnel; sphere calibration at St. Matthew Island
Aug 6-7	Transit to Nome, Alaska
Aug 8	Inport Nome; exchange scientific personnel
Aug 9-10	Transit back to survey area
Aug 10-30	EIT survey of EBS shelf and slope; intership calibration with Russian research vessel <i>Professor Kaganovskiy</i>
Aug 31	Transit to Unalaska Island
Sep 1	Sphere calibration in Anderson Bay
Sep 2	Disembark scientific personnel in Dutch Harbor;

end of cruise.

OBJECTIVES

The principal objective of the cruise was to collect echo integration data and midwater and bottom trawl data necessary to determine the distribution, biomass, and biological composition of walleye pollock in the survey area.

Secondary objectives were to:

1. collect pollock target strength data for scaling echo integration data to estimates of absolute abundance;
2. calibrate the 38-kHz and 120-kHz scientific acoustic systems using standard sphere techniques;
3. conduct an intership calibration of acoustic systems between the *Miller Freeman* and the Russian research vessel *Professor Kaganovskiy*;
4. collect and preserve whole stomachs from pollock for food habits studies (contact: Patricia Livingston, AFSC);
5. collect and preserve age-0 and older pollock for genetic studies of stock origin (contact: Dennis Powers, Hopkins Marine Laboratory);
6. collect zooplankton, juvenile pollock, and stomachs and tissue samples from adult pollock to examine incidence of cannibalism using stable isotope ratios (contact: Sam Wainright, Rutgers University);
7. collect and preserve age-0 pollock for investigation of diseases and parasites (contact: Frank Morado, AFSC);
8. sample predominantly euphausiid and macrozooplankton mix scattering layers to assist with distinguishing echosign acoustically (contact: Denise McKelvey, AFSC);
9. examine physical, biological, and acoustical conditions around the Pribilof Islands in preparation for later work planned by the Fisheries-Oceanography Coordinated Investigations (FOCI) group (contact: Matt Wilson, AFSC);
10. collect zooplankton and physical data for calibrating sensors on FOCI biophysical moorings on the southeast Bering Sea shelf (contact: Matt Wilson, AFSC);

11. collect juvenile pollock and other fishes to augment collections made by the Japanese research vessel *Oshoro maru* (contact: Matt Wilson, AFSC);
12. collect age-1 pollock from inside and outside areas of subsurface waters under 2 deg. C to test for size differences between areas and to examine general prey species (contact: Tina Wyllie-Echeverria, Pacific Marine Environmental Laboratory [PMEL]);
13. collect grab samples of surficial sediments and evaluate seabed classification hardware and software (contact: Bob McConnaughey, AFSC);
14. capture and monitor pollock in a live tank to examine feasibility of tagging via trawling (contact: Vidar Wespestad, AFSC);
15. collect squid and fish for the National Marine Mammal Laboratory (NMML) prey reference collection and studies on fatty acids, stable isotopes, and stock differentiation (contact: Kathryn Chumbley, AFSC);
16. collect physical oceanographic data including temperature and salinity profiles at selected sites, plus continuously monitor sea surface parameters (e.g., temperature, salinity, and light level); and
17. collect water current profiles using the vessel's acoustic Doppler current profiler (ADCP) system (contact: Ned Cokelet, PMEL).

VESSEL, ACOUSTIC EQUIPMENT, AND TRAWL GEAR

The survey was conducted on board the NOAA ship *Miller Freeman*, a 66 m (216 ft) stern trawler equipped for fisheries and oceanographic research. Two Simrad¹ split-beam transducers, one operating at 38 kHz and the other at 120 kHz, were mounted on the bottom of the vessel's centerboard. With the centerboard fully extended, the transducers were 9 m below the water surface. System electronics were housed in a portable laboratory mounted on the vessel's weather deck. Acoustic data were collected at both frequencies with a quantitative echo sounding system (Simrad EK500). Data from the Simrad EK500 echo sounder were stored and processed using Simrad BI500 echo integration and target strength

¹ Reference to trade names or commercial firms does not constitute U.S. government endorsement.

data analysis software on a SUN workstation.

Midwater and near-bottom echosign was sampled using an Aleutian wing 30/26 trawl (AWT). The AWT is a full-mesh wing trawl constructed of nylon except for polyethylene in the codend and aft section of the body. The headrope and footrope each measured 81.7 m (268 ft). Mesh sizes tapered from 325.1 cm (128 in) in the forward section of the net to 8.9 cm (3.5 in) in the codend. The net was fitted with a 3.2 cm (1.25 in) codend liner. The AWT was fished with 82.3 m (270 ft) of 1.9 cm (0.75 in) diameter 8x19 non-rotational dandyline, and 453.6-kg (1,000-lb) or 226.8-kg (500 lb) tom weights on each side.

Fish on bottom were sampled with an 83/112 bottom trawl without roller gear. Net mesh sizes ranged from 10.2 cm (4 in) forward and 8.9 cm (3.5 in) in the codend to 3.2 cm (1.25 in) in the codend liner. Headrope and footrope lengths were 25.6 m and 34.1 m (83.9 ft and 111.9 ft), respectively, and the breastlines measured 3.4 m and 3.2 m (11.3 ft and 10.5 ft).

Age-0 pollock and zooplankton were targeted with a Marinovich trawl. Meshes in the Marinovich trawl measured 7.6 cm (3.0 in) forward, 3.2 cm (1.3 in) in the codend, and 0.32 cm (0.125 in) in the codend liner. Headrope and footrope lengths were each 9.1 m (30 ft).

A Methot trawl was also used to target age-0 pollock and zooplankton. Its mouth was formed by a square frame measuring 2.27 m (89.5 in) on each side. Mesh size was 2 mm X 3 mm (0.08 in X 0.12 in) in the main part of the net, and 1 mm (0.04 in) in the codend. A 1.83 m (6 ft) dihedral depressor was used to generate additional downward force. A calibrated General Oceanics flow meter was attached to the mouth of the Methot trawl to determine the volume of water filtered during trawling.

Five m² (53.8 ft²) "Fishbuster" trawl doors [1,247.4 kg (2,750 lb)] were used with the AWT, 83/112, and Marinovich trawls. When the Marinovich trawl was used, a 15.24 m (50 ft) long, 2.5 cm (1 in) diameter spectra restrictor line was connected between the ends of two 12.8 m (270 ft) long, 1.9 cm (0.75 in) diameter 6x19 wire ropes trailing each trawl door. From the restrictor line aft led two pairs of 18.3 m (60 ft) long, 1.3 cm (0.5 in) diameter 6x19 wire ropes to the head rope and foot rope of the Marinovich trawl. The Methot trawl was attached to a single cable that was fed through a stern-mounted A-frame. Trawl depth and vertical and horizontal openings of AWT, 83/112, and Marinovich trawls were monitored with a WesMar third-wire system

attached to the headrope. Trawl depths of Methot trawls were monitored with a SCANMAR depth sensor.

Tow depth profiles and water temperature at depth for all trawls were obtained by attaching a small, retrievable microbathy-thermograph (MBT) to the net, or, with Methot trawls, to the frame. Water temperature and salinity profile data were collected at calibration sites with a Seabird CTD system. Additional temperature profile data were obtained by launching expendable bathythermographs (XBTs). Sea surface oceanographic data and environmental data were collected and stored on the *Miller Freeman's* Scientific Collection System (SCS). Ocean current profile data were collected using an ADCP system with transducers located in the vessel's centerboard.

SURVEY METHODS

The EIT survey of the EBS shelf and slope consisted of parallel, north-south transects that started near 160° W (Fig. 1) and proceeded northwest to the U.S./Russia convention line. Transects were spaced about 20 nmi apart and were chosen to coincide with lines of bottom trawl stations sampled by groundfish survey vessels. Southern extents of transects west of Unimak Island were near the 200 m depth contour of the shelf. Southern extents of transects 1-8 were limited by Unimak Island and the Alaska Peninsula. Northern ends of transects were chosen based on lack of significant echo sign judged to be from pollock. Northern endpoints of transects 1-16 ranged in depths from 55 m to 76 m and were located between 57° and 58° N. Permission to enter the Russian Exclusive Economic Zone (EEZ) was not granted, thus the northern extents of transects 21-29 ended at the U.S./Russia convention line. Endpoint depths along the convention line increased westward from 77 m to 252 m.

Standard survey operations occurred only during daylight hours. Night operations were reserved for collection of target strength data, age-0 trawling, ichthyoplankton sampling, and ocean bottom grab sampling. Favorable weather conditions permitted an average vessel speed of roughly 12 knots while running transects. Both acoustic systems (38 kHz and 120 kHz) collected echo integration data and split-beam target strength data concurrently. Echo integration data from the 38-kHz system were used to provide estimates of pollock abundance. Echo integration data from the 120-kHz system, in conjunction with data from the 38-kHz system, will be examined to attempt to determine the feasibility of acoustically distinguishing echo sign produced by macrozooplankton aggregations, euphausiids, and pollock, and the feasibility of determining mean size of selected euphausiid aggregations using acoustic scattering models.

Collection of target strength data requires suitable conditions (e.g., low fish density, monospecific aggregation, unimodal size distribution, and calm seas) and involves passing repeatedly (at speeds of less than 4 kts) over an aggregation of pollock, then collecting biological data from hauls conducted in conjunction with the collection of acoustic data. Attempts were made during the survey to collect target strength data, but unsatisfactory conditions (e.g., mixed catch composition, interference from non-pollock echo sign in the water column) prevented generation of acceptable target strength values.

Midwater and bottom trawl hauls were made at selected locations (Figs. 2 and 3) to identify echosign and to provide biological samples. Average trawling speed was about 3 knots. The vertical net opening for the AWT averaged 25 m and ranged from 15 m to 32 m. Vertical net openings for the 83/112 and Marinovich trawls were 3 m and 6 m, respectively. Standard catch sorting and biological sampling procedures were used to provide weight and number by species for each haul. Pollock were further sampled to determine sex, fork length, body weight, age, maturity, and ovary weight of post-immature females. An electronic scale was used to determine all weights taken from individual pollock specimens. Fork lengths of age-1 and older pollock were measured to the nearest cm and recorded with a Polycorder measuring device (a combination of bar code reader and hand-held computer), then downloaded into a personal computer. Standard lengths of age-0 pollock were measured to the nearest mm and recorded onto a tally sheet before being transferred to a personal computer. Maturities were determined by visual inspection using a new eight-stage scale that attempts to describe spawning stages better than the previously used five-stage scale (immature, developing, prespawning, spawning, spent) and to provide maturity data consistent with nomenclature used by other nations conducting research on walleye pollock. The eight-stage scale can be expressed in terms of the five-stage scale as follows: immature, developing 1 and 2, pre-spawning 1 and 2, spawning, and post-spawning 1 and 2. Pollock stomachs and macrozooplankton samples were preserved in a 10% formalin solution. Samples of age-0 pollock were either preserved in formalin or frozen whole. Age-1 pollock samples, adult pollock tissue samples, and fish for the NMML study were frozen whole.

PRELIMINARY RESULTS

Standard sphere calibrations

Four standard sphere calibrations were conducted before and during the cruise. The 38-kHz acoustic system was calibrated each time, and the 120-kHz acoustic system was calibrated three

times. For the calibrations, the *Miller Freeman* was anchored fore and aft in 46-108 m of water. Acoustic properties of two copper spheres suspended below the transducer were measured. Split-beam target strength and echo integration data collected with the Simrad EK500 system were used to determine acoustic system gain parameters and transducer beam pattern characteristics. Calibration results for both systems are presented in Table 1. No significant differences in gain parameters or transducer beam pattern characteristics were observed among any of the four calibrations.

Intership Calibration

From Aug 22-23, the *Miller Freeman* and the Russian research vessel *Professor Kaganovskiy* conducted an intership calibration of their acoustic data collection systems to enable comparison of density estimates derived from the two systems. Twenty-two transects (average length 5.1 nmi) were run with one vessel leading the other; the two vessels were separated by one nautical mile. Vessel speeds were around 6 kts. Leader-follower positions were switched periodically to reduce potential biases affecting acoustic data collection. Transects were bordered by 60° 44' N on the north, 176° 12' W on the east, 178° 5' W on the west, and 60° 19' N on the south. Bottom depths ranged from 120-150 m. Preliminary analysis suggested that acoustic densities measured by the U.S. system agreed relatively well with densities measured by the Russian system.

EIT Survey

Trackline mileage (including cross transects, haul operations, intercalibration, and searching for potential fishing sites) totaled approximately 9178 nmi. Greatest densities of walleye pollock were observed from St. Matthew Island west to the U.S./Russia convention line (Fig. 1). Moderate densities were observed north of Unimak Island and the Alaska Peninsula. A few isolated areas of high density were observed around the Pribilof Islands and west of Unimak Island. However, relatively little walleye pollock echosign was observed in this region overall.

In the 8 transects north of the Alaska Peninsula and Unimak Island, and in transects encompassing the Pribilof Islands and St. Matthew Island (14 through 20), pollock density observed from the bottom 10 m of the water column (excluding the near-bottom 1/2 m) was greater than that observed off-bottom (10 m above bottom to 9 m below the surface) (Fig. 4). For transects 21 through 28, which corresponded with highest average pollock densities, the opposite was true.

Biological data and specimens were collected from 51 midwater (50

AWT and 1 Marinovich), 7 bottom, and 50 Methot trawl hauls. Trawl station and catch data are summarized in Tables 2 and 3. Oceanographic data were collected from 5 CTD casts (Table 4), 57 XBT drops (Table 5 and Fig. 5), and 104 MBT casts (Table 6). Fifty-five grab samples of surficial sediments were collected (Table 7).

Pollock was the most abundant fish species captured in both AWT (Table 8) and bottom trawl hauls (Table 9), accounting for approximately 83% of catch composition by weight for both gear types combined. More than 99%, by weight, of the AWT haul catch composition was composed of pollock and jellyfish. However, most jellyfish (65.5%) were caught east of the Pribilof Islands. Besides pollock, bottom trawl hauls caught significant numbers of yellowfin sole, *Opilio* Tanner crab, rock sole, and flathead sole; their combined weights comprised over 8% of total catch. Methot catch composition was dominated by jellyfish, which comprised over 97% of total weight. However, euphausiids, unidentified fish larvae, amphipods, tunicates, and crab larvae were numerically most abundant. The one Marinovich trawl haul caught 1.9 kg of age-0 pollock, 3.9 kg of jellyfish, and two juvenile prowlfish. Types of biological data and numbers of samples and measurements collected from all trawl types are listed in Tables 10 through 12.

Pollock ranged in fork length (FL) from 12 to 71 cm (Fig. 6a). Size differences (mean FL) between males and females averaged less than 1 cm within hauls. Pollock caught in AWT hauls averaged about 9 cm smaller than fish caught in bottom trawl hauls (36.7 cm vs. 45.5 cm, respectively). AWT hauls that fished 0-3 m off bottom (foot rope depth) caught pollock that averaged about 4 cm larger than pollock caught from hauls with gear depths more than 3 m off bottom (39.3 cm vs. 35.7 cm, respectively). Preliminary abundance estimates by length (Fig. 6a) revealed dominant length modes at 17 cm and 36 cm northwest of the Pribilof Islands area, and around 50 cm near the Pribilofs and to the east. Fish northwest of the Pribilofs were, on average, smaller than fish near the Pribilof Islands and east. Nearly all fish less than 35 cm were observed northwest of the Pribilofs, with most near the U.S./Russia convention line. Pollock abundance by age in the northwest area was quite different than that from near the Pribilof Islands and areas east (Fig. 6b). In the northwest, the 1992 year class (age 4) dominated, followed by the 1995 year class (age 1). Near the Pribilof Islands and to the east, the 1989 year class (age 7) was most numerous. Of 1,082 male and 922 female walleye pollock whose gonad maturity was determined, none was in spawning condition.

SCIENTIFIC PERSONNEL

<u>Name</u>	<u>Sex/ Nationality</u>	<u>Position</u>	<u>Organization</u>
<u>Leg 1 (Jul 18-Aug 7)</u>			
Neal Williamson	M/USA	Chief Scientist	AFSC, MACE
Dan Twohig	M/USA	Instrument Chief	AFSC, MACE
Kathryn Chumbley	F/USA	Wildlife Biologist	AFSC, NMML
Lorenzo Cianelli	M/Italy	Fish. Biologist	AFSC, FOCI
Stephen de Blois	M/USA	Fish. Biologist	AFSC, MACE
Mike Guttormsen	M/USA	Fish. Biologist	AFSC, MACE
Nancy Krause	F/USA	Teacher	MTS
Paul von Szalay	M/USA	Biol. Sci. Tech.	AFSC, Groundfish
Matt Wilson	M/USA	Fish. Biologist	AFSC, FOCI

Leg 2 (Aug 9-Sep 2)

Jim Traynor	M/USA	Chief Scientist	AFSC, MACE
Dan Twohig	M/USA	Instrument Chief	AFSC, MACE
Stephen de Blois	M/USA	Fish. Biologist	AFSC, MACE
Taina Honkalehto	F/USA	Fish. Biologist	AFSC, MACE
Denise McKelvey	F/USA	Fish. Biologist	AFSC, MACE
Ann Throckmorton	F/USA	Teacher	WC

AFSC - Alaska Fisheries Science Center, Seattle, WA
 FOCI - Fisheries-Oceanography Coordinated Investigations
 MACE - Midwater Assessment and Conservation Engineering
 MTS - Mannington Township School, Salem, NJ
 NMML - National Marine Mammal Laboratory
 WC - Westminster College, New Williamtown, PA

 For further information contact Dr. Gary Stauffer, Director,
 Resource Assessment and Conservation Engineering Division,
 Alaska Fisheries Science Center, National Marine Fisheries
 Service, 7600 Sand Point Way Northeast, Building 4, BIN C15700,
 Seattle, WA 98115-0070. Telephone (206) 526-4170.
